NOISE ELEMENT

FOR THE

SACRAMENTO COUNTY GENERAL PLAN

City planning
County planning

Noise abatement
Sacto Co.

APPROVED BY
SACRAMENTO COUNTY
POLICY PLANNING COMMISSION
RESOLUTION NO. PO-75-11
AUGUST 19, 1975

ADOPTED BY
SACRAMENTO COUNTY
BOARD OF SUPERVISORS
RESOLUTION NO. 75-944
SEPTEMBER 17, 1975

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NOISE ELEMENT

Introduction

State legislation adopted in 1971 requires that a Noise Element be adopted by cities and counties as part of their General Plans (Section 65302(g) of the Government Code). The functions of this element are to identify noise problems in the community, particularly with regard to transportation facilities; to set standards and criteria for noise emissions from transportation facilities and fixed noise sources; and to make recommendations regarding site or route selections and land use to help alleviate the problems.

The Sacramento County Board of Supervisors have explicitly declared their intention in the major policies of the Sacramento County General Plan to protect environmental quality to the highest level possible consistent with reasonable development needs, and to foster a fully coordinated approach to all actions which affect the physical environment. There is no question that excessive noise is detrimental to the environment, and that it must be controlled if the environment is to be a pleasant place in which to work and live.

GOAL: To provide the residents of Sacramento County an environment as free as possible from unnecessary noise, and to reduce the level of necessary noise, in order to improve the overall quality of life in the County.

Background

The environment is full of sounds of almost infinite variety. The sounds may be loud or soft, high or low-pitched, quick bursts or long drawn-out, pleasant or unpleasant. Few people object to pleasant sounds. Unfortunately, people disagree on what constitutes unpleasant sounds, or noise.

The subjective nature of noise makes it a difficult subject to deal with. Music to one person may be noise to another. Music to one person at 8 PM may be noise to the same person at 2 AM. A pleasing musical selection may become unbearable noise if it is too loud. Noise, then, is what each person thinks it is. However, there are many sounds in the environment that are defined as noise by nearly everyone. We will consider mostly these sounds.

Most people would agree that a noise free environment (as opposed to a sound free environment) is a desirable thing. However, man cannot close his ears the way he can close his eyes. Until the human race develops earlids, we will have to deal with noise some other way.

The statement is often made that the noise level in our environment is constantly increasing. True or not, our urban environment is unmistakably noisy. Most of the noise is man-made, and the majority of it is due to transportation facilities and equipment. Airplanes, railroads, trucks, cars, and motorcycles all contribute to the din that assaults our ears daily. We must not neglect other marvels of the modern world, however. Jackhammers, air-conditioning compressors, pile drivers, heavy manufacturing of many kinds, and many other fixed sources

generate considerable noise. Most of these sources are found in urban areas, where most people are also found, concentrating the assault on the ears of as many people as possible.

Effects of Noise

It has been known for a long time that prolonged exposure to high levels of sound can produce permanent hearing loss. Evidence is accumulating that there are also other, more subtle physiological effects, as well as psychological, social and economic ones.

Physiological Effects:

In addition to the hearing loss mentioned above, it appears that nearly all urban dwellers lose hearing with age. This loss has been assumed to be a natural part of the aging process. However, there is evidence to indicate that people in non-mechanized, "uncivilized" cultures who are not exposed to the noise of an industrial society do not lose hearing with age. This finding suggests the possibility that quieting our environment might preserve our hearing.

Noise causes physiological changes in humans. Typical reactions include elevated heartbeat, respiration, and muscle tension. Such stress can contribute to erratic physical performance. A person performing difficult tasks under high noise conditions will characteristically perform at a normal level for a short period, then perform almost not at all, then perform normally again for a short period, and so on. Needless to say, such performance impairs productivity.

Psychological Effects:

Demonstrable psychological effects of excess noise include irritability and impaired mental acuity. A person exposed to high levels of noise frequently becomes snappish and less able to concentrate. There is also some evidence that noise may contribute to depression.

Social Effects:

Excess noise interferes with social situations. Some people live or work so near an airport that conversation becomes impossible when an airplane is running up its engine or taking off. Any interaction requiring verbal exchanges may be disturbed by excess noise.

Economic Effects:

Excess noise definitely results in economic costs to the community. Land near airports or freeways is poorly suited for many uses because of noise problems. Structures built near high noise generators must utilize expensive sound insulation to maintain acceptable levels of quiet inside. Offices and factories may suffer increased absenteeism, and decreased productivity as a result of exposure of employees to excessive noise.

Description and Measurement

The measurement and description of noise is subject to a set of problems all its own. Annoyance is very difficult to quantify.

A "pure" tone has two basic qualities: intensity or volume, and frequency or pitch. However, we almost never hear pure tones in our everyday lives. The sounds we hear are complex mixtures of tones and overtones of varying volume, pitch, and duration. Some combinations sound pleasant and can be musical, others are dissonant and irritating.

Once a sound is produced, by whatever source, it must travel to its receiver. The path of the sound can have substantial effect. Sound travels at different speeds in air, water, metal, and other media; it can be focused, reflected, or dampened by intervening structures or barriers. Sound propagation is different across a paved parking lot than across an open field.

When the sound reaches its receiver, the problem becomes complicated still further. The human ear does not respond in linear fashion to either pitch or loudness. At low volume, the ear is more sensitive to middle frequencies than to high or low frequencies in the audio spectrum. This phenomenon diminishes as volume increases. The response of the ear to volume changes is more or less logarithmic, which means, in this case, that a sound containing twice the energy of another sound will be perceived as only slightly louder. This mechanism allows us to hear sounds as different as a pin dropping and a jet airplane taking off without damage to our ears, even though the energy difference between the two sounds is or the order of 10^{12}, or one trillion.

If all this were not enough, psychological reactions can also enter in. A sudden bang or crash causes a "startle" reaction, and is usually considered more annoying than a sound of equal intensity which has a gradual onset. Sirens

or bells may trigger a learned psychological reaction and be more annoying as a result.

Noise Description Systems:

All these variables make it difficult to even describe a sound, let alone measure it and compare it with other sounds in consistent terms. Many attempts have been made to develop systems to describe sound. One of the most successful and widely used systems is based on the unit called a "bel", after the inventor of the telephone. Unfortunately, this system deals only with loudness, and with modification, frequency. It cannot deal with duration of a sound or with intermittent or repetitive sounds. However, it does provide an effective tool with which to start.

The quantity called the "bel" is too large for convenient use, so a unit called a decibel (dB) which is one-tenth as large is generally used. Decibels are expressed on a logarithmic scale. This means, for example, that a sound described as 20 decibels does not contain merely twice as much energy as a ten decibel sound, but 10 times as much energy. This scale correlates closely with the non-linear volume characteristic of the human ear.

Modification of this system is frequently used to more closely approximate the non-linear pitch reception characteristic of human hearing. A weighting factor is applied to the decibel scale to compensate for reduced human sensitivity to high and low audio frequencies. The set of weighting characteristics most commonly used is called the A-scale, and sounds expressed in decibels weighted by the A-scale are abbreviated dBA.

Even with a scale to describe individual sounds, a description of "noise" is difficult. To do the job perfectly, a noise measure would have to take into account loudness, pitch, duration, frequency, number of noise events, the time of occurrence, whether the sound was sustained or sudden or repeated, and so on. No such measure has yet been developed. Several different systems

are in use, some of which are described in the appendices. The noise contour maps supplied by other agencies utilize several different systems, and they are generally not interchangeable, although approximate conversions may be made in some instances.

Transportation Noise Sources

Freeways:

Diesel trucks on a freeway frequently exceed 80 dBA at the edge of the freeway right-of-way. Automobiles at freeway speeds are not quite as loud but can easily attain 75 dBA at the edge of the right-of-way. Motorcycles with poorly designed mufflers can exceed the noise output of either cars or trucks.

There are many components to noise from freeways. The loudest noises typically come from poorly designed or faulty exhaust systems, particularly with regard to motorcycles and trucks. Another component is tire whine. Certain tread designs generate a loud, distinctive whine at the tread-pavement interface. This problem is most often found on trucks, and can only be solved by changing tread design or pavement composition. A third component which varies widely from vehicle to vehicle is wind noise. The wind noise varies with the shape, size, streamlining, and exterior hardware mounted on a vehicle. The noise is also affected by the direction the wind is blowing, or the absence of wind.

Airports:

Air transportation constitutes the largest single noise problem for many communities, including some which do not have airports. Aircraft, particularly large jet aircraft, are extremely loud and distribute their noise over very wide areas.

Some characteristics of engine noise, particularly on jet aircraft, are especially obnoxious and hard to control. Turbine whine from jet engines is

a particular problem because much of the noise is concentrated in frequencies where human hearing is most sensitive. Reciprocating engine, propeller-driven aircraft can generate nearly as much noise, but the frequency distribution is such that most people find the noise somewhat less offensive.

Obviously, the noise problem is not limited to the airport proper, but extends some distance under the approach and takeoff zones. Of the three major airports in the unincorporated area of Sacramento County, one has substantial development nearby (McClellan). At the other two (Mather and Metro) the situation is not yet as serious.

Railroads:

Railroad trains operating at moderate speed on relatively level tracks produce noise levels approximately the same as those of a diesel truck at freeway speeds. Obviously, duration of exposure to a train is vastly different from exposure to a single truck. Equally obviously, the average person encounters far fewer trains than trucks in the course of a normal day. As with other noise sources, there are many variables for railroads. The rate of speed of the train, whether the track is upgrade, level, or downgrade, whether switches or frogs are found in the track, and whether the track is straight or curved, all have substantial effects on the overall noise level generated by a train. The frequency distribution of train-generated noise tends to be concentrated in the lower ranges. While these noises are harder to control, they are also found somewhat less objectionable by most people.

Yard operations are so different from line operations as to constitute almost a separate category. While line operations produce the usual rumble and clickety-clack most people are familiar with and expect from trains, yard operations are generally carried on at a much lower rate of speed. The sounds emanating from a switchyard or a repair yard typically consist of thumps, bangs, crashes, whines, and screeches. As a rule, line operations

are well tolerated by the public and generate a low volume of complaints. Yard operations have much greater potential for annoyance.

Fixed Noise Sources

"Fixed noise source' is a broad term applied to localized noise sources, even if they move a little. It includes air-conditioning compressors, gravel plants and other industrial facilities, lawn mowers, power tools, chain saws, and maybe even barking dogs. Certainly these do not all generate the same amount of noise or annoyance. Surveys conducted for the Sacramento County Health Agency by the Sacramento City Police Department and the Sacramento County Sheriff's Department reveal that the majority of noise complaints called in by citizens concern barking dogs or loud parties. Clearly, these sources do not generate the most noise, but at the present time, at least, they generate the most complaints.

Construction equipment generates considerable noise, particularly in large commercial areas. The argument is frequently made that noise from construction is temporary, and that it will disappear in a week or a month or a year. This is true for any one project, but in any major commercial area, construction is a permanent condition. Some project or another is always being noisily worked on.

NOISE LEVELS IN SACRAMENTO COUNTY

Ambient Noise

The ambient noise contour map (page 18) was prepared by the Sacramento County Health Agency and Wilson, Ihrig and Associates, Inc., (Oakland based Acoustical Consultants) to aid in the preparation of the proposed Sacramento County Noise Abatement Ordinance (Title 6, Chapter 6.68, SCC.) The methodology of preparation and notes on the conversion of the labelling system are included in Appendix B. The maps show generalized contours for ambient noise levels in the City and County of Sacramento. The contours clearly show that freeway corridors generate more or less constant noise levels far above those of surrounding areas.

Comparing the 1973 General Plan Land Use Map with the ambient noise contour maps shows that the majority of the areas designated for urban residential uses are within a few dB of the "satisfactory" levels. Bear in mind that the ambient noise maps were prepared by excluding specific nearby noise events such as vehicles idling in a driveway. The maps indicate a background noise level, not necessarily a typical noise level.

Specific Noise Sources

The other maps show contours around specific noise generators. Those around airports show the contours in their entirety, while those for railroads and freeways show typical sections for the areas shown on page 28.
The master maps containing contours for the entire County are on file at the Sacramento County Planning Department. The various systems of noise measurement used on these maps are defined and explained in Appendix A.

It is important not to overemphasize noise contours, which are merely tools to aid in analyzing a very complex phenomenon. The calculations which are used to produce the contours are of necessity somewhat arbitrary. The

problem is noise, not the location of lines on a map. Everyone knows that airports and freeways are noisy, and the most sophisticated analysis in the world has no effect on the noise. Describing the problem does not solve it. Nonetheless, the contours and the calculations which produce them do provide a means for estimating the approximate boundaries of the noise impacted areas and the magnitude of the disturbance.

Noise Regulation and Abatement

There are three potential approaches to control of noise. One is to reduce the noise output at the sources, the second is to interfere with the transmission path, and the third is to insulate the noise receiver. Attempts to control noise at the present time utilize all three approaches.

Clearly, the most desirable way to control noise is to prevent its generation. It is better to have an environment free from noise than to modify the environment to protect us from the noise.

Unfortunately, the County is preempted from regulating most transportation noise sources by State and Federal jurisdictions. The interstate commerce provisions of the Constitution and statutes passed by Congress and the California legislature effectively preclude the County from regulating freeways, railroads, or aircraft. Jet airplanes and locomotives which could be called "quiet" are not in evidence. However, relatively quiet trucks and motorcycles do exist. The County should encourage State and Federal authorities with jurisdiction to require quieter exhaust systems on all motor vehicles, engines and aircraft. Tread design should be regulated to eliminate unnecessary tire whine. The matter of wind noise is considerably harder to regulate. We will probably see some emphasis on better streamlining in the future because more effective streamlining increases gas mileage. A pleasant side effect is that it also usually reduces wind noise.

Nearly all fixed mechanical or construction equipment can be made quieter. Some equipment merely needs better muffling; other equipment would require extensive (and often expensive) redesign. Some "quiet" equipment is already in use, and the degree of noise reduction can be surprising. A pile driver is one of the more obnoxious noisemakers on many construction projects. Muffling the noise of the heavy hammer repeatedly hitting the piles could be only partially effective at best. However, for many applications, a newly developed pile driver can be used which vibrates the pile into the ground instead of pounding it in, frequently at less cost per pile. Needless to say, the noise generated is considerably less with vibration drivers than with the conventional pile driver. Jackhammers, too, can be muffled to a large degree. While the noise from the tip biting into concrete or paving is hard to muffle, effective methods of reducing the noise of the air valves which vent the spent compressed air which drives the jackhammers of this type already exists. Use of these quieter machines plus better muffling of the air compressors would measureably reduce the noise level around construction projects.

The fact that the County has jurisdiction does not mean that there is no problem with regulation. For some sources, such as stereo equipment or amplified outdoor events, noise control is a matter of producing appropriate ordinances and enforcing them. For lawnmowers, garden tractors, and portable gasoline powered compressors, most of the noise is due to inadequate muffler design. The technology exists to make equipment of this nature quiet enough to meet the standards in Figure 1.

On the other hand it is very difficult to reduce the noise generated from facilities such as gravel plants. Certain other kinds of industrial equipment are also noisy by nature, and the technology may not yet exist to make them so quiet as to be inoffensive.

Interrupting the transmission path of noise is not nearly as efficient

as preventing its generation in the first place, but it can be used to reasonable effect in some situations. Freeways provide the most conspicuous example. The road surface may be built elevated or below ground, or masonry walls may be built between the right-of-way and adjacent development. Standing in the vicinity of a freeway so treated will make it very clear that the noise has not been eliminated but it is typically 6 to 10 dB quieter, which is better than nothing.

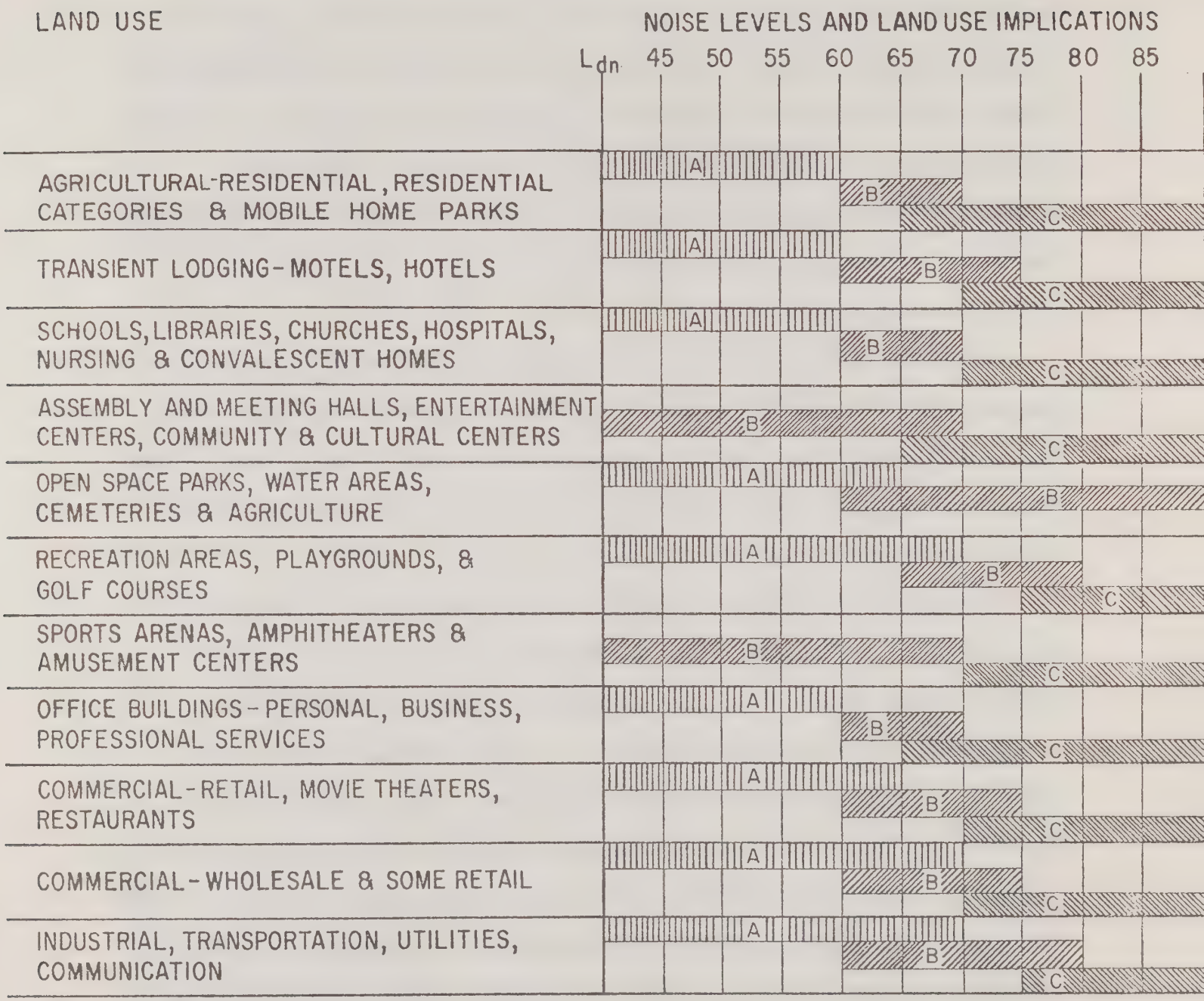
Some noise emanating from aircraft on the ground can be controlled to the extent that it can be deflected. Baffles and special muffling devices for engine run-ups have been and are being used to control some noise. These measures are only partially effective, and obviously do nothing to control noise from flying airplanes.

Insulating the receiver to protect against noise is done in several ways. Workers in extremely noisy environments are required to wear ear protection, which is the most direct approach. Homes and offices can be constructed to reduce noise penetration. A typical dwelling unit reduces noise about 20 dB from the outside to the inside. This figure can be increased to 40 or even 50 dB, but the cost rises even faster than the noise is reduced. A figure frequently quoted and probably obsolete by now is $8.00 per square foot for about 40 dB noise attenuation. A somewhat more primitive approach is to insulate the receiver by distance. Since noise is gradually attenuated by distance, keeping the receiver far away from the source will "solve" most of the problem. This method is almost the only one available in the vicinity of airports, and it can be applied to freeways and railroads.

Land Use Compatibility

Not all land uses require low levels of noise. A motorcycle park can certainly tolerate a much noisier environment than a school. This is recognized in the following figure which provides a guide to compatibility

LAND USE COMPATIBILITY FOR COMMUNITY NOISE



A — SATISFACTORY; NO SPECIAL REQUIREMENTS.

B — USE SHOULD BE PERMITTED ONLY AFTER CAREFUL STUDY & INCLUSION OF PROTECTIVE MEASURES IF NEEDED.

C — USE SHOULD BE DISCOURAGED. IF PERMITTED, NOISE REDUCTION MEASURES MUST BE TAKEN.

NOTE: NOISE INSULATION FEATURES FOR NEW CONSTRUCTION SHOULD BE SUCH THAT AN INTERIOR L_{dn} OF 45 dB WILL BE ACHIEVED IN AREAS WHERE PEOPLE SLEEP.

with specific noise levels.

Figure 1 should be approached as a tool to evaluate the impact primarily of noise levels from the surrounding uses on a proposed use. Other tools, such as Environmental Impact Reports, exist to help evaluate impacts of proposed uses on the surroundings. Nonetheless, a proposed use which clearly generates noise louder than the "A" levels in Figure 1 certainly would suggest a need for careful review.

Recommended Noise Control Program and Implementation

The preceding pages may have left the impression that noise control is impossible. This is not true; it just looks that way.

Awareness of the noise problem is gradually rising. Noise pollution has not yet achieved the attention that water and air pollution have, but interest is increasing. Much of the problem lies in lack of information and effective methods. More research is needed.

The fact that noise control is a relatively young and undeveloped field is no reason to conclude that there is nothing to be done. The battle for a quieter environment may take a long time, but it can be won.

Truly effective noise reduction means that noise sources must be made quieter. Interfering with noise transmission or insulating receivers treats only symptoms, not the disease. Any noise program that does not address the question of actual noise reduction cannot be expected to make significant progress in solving the noise problem.

The reduction of noise generation from all sources is not now available to the County, either legally or technologically. Noise generation needs to be reduced wherever feasible, and buffers and insulation used to help control other sources while we work to achieve the ability to reduce the output of noise.

The following implementation proceedures are recommended:

Measures providing potential source reduction:

1. Request and support stronger State and Federal legislation to require reduced noise generation from sources under those jurisdictions. Automobile related noise such as poor mufflers and tire whine should be emphasized. Progress should be reviewed annually by the Board of Supervisors' Environmental Protection and Development Committee.
2. Designate and staff a task force (alternatively, instruct each County department) to develop a program to reduce or control noise generation from sources under the County's jurisdiction. The programs should address such problems as pumps, compressors, garbage trucks, shredders, road maintenance equipment, and other noise generators operated by the County. Annual reports should be made to the Board on progress made in lowering noise levels in the County, including recommendations for further measures as laws and technology make further noise reductions available.
3. Set and enforce measurable standards for noise reduction and control on construction projects, equipment purchase contracts, and other contracts let by the County. The Health Agency and the Public Works Department should cooperate in implementing this recommendation.
4. Adopt and systematically enforce the Noise Abatement Ordinance, Title 6, Chapter 6.68, Sacramento County Code. Review the ordinance annually to make sure it reflects the most up-to-date legal and technological noise reduction capabilities available.

Measures providing buffering or insulation:

Rather than reducing noise levels these measures would reduce noise exposure and would thus not really improve the ambient levels in the County. Nonetheless, these recommendations would reduce the overall noise impact on most people.

5. Ensure that applicable building standards in Sacramento County require dwelling units capable of maintaining interior noise levels no greater than L_{dn} 45 dB. This standard should be adopted in addition to those found in the routinely adopted Uniform Building Code until such time as the UBC equals or exceeds this standard.

6. Require that the construction by the County of pumping plants, major roads, or other facilities includes effective buffering measures to meet the standards in Figure 1 for adjacent areas.

Ongoing administrative programs:

7. Review, and amend if necessary, the General Plan, Community Plans, and County Ordinances to reflect the noise recommendations contained in this Element. Update this Element at least at 5 to 7 year intervals. The Planning Department should implement this recommendation.

Freeway Measures

Freeway noise affects more people on a more continuous basis than any other noise source. Railroad line operations produce intermittent impact, and yard operations are relatively localized. Airports have a severe impact on those people living nearby, and even those who live nowhere near airports are subject to aircraft flyovers. Nonetheless, nothing beats a freeway for continuous obnoxiousness affecting very large numbers of people.

Several of the measures in the preceding pages have potential impact for freeway noise. Measure 1 encompasses many possible areas, but provides no specific remedies for the County. It should be noted that the State now builds noise walls or takes other measures if a new freeway is built through existing residential areas. Of course, this does not solve the problem of new development adjacent to existing freeways.

Measure 5 provides an alternative approach which is not freeway-specific

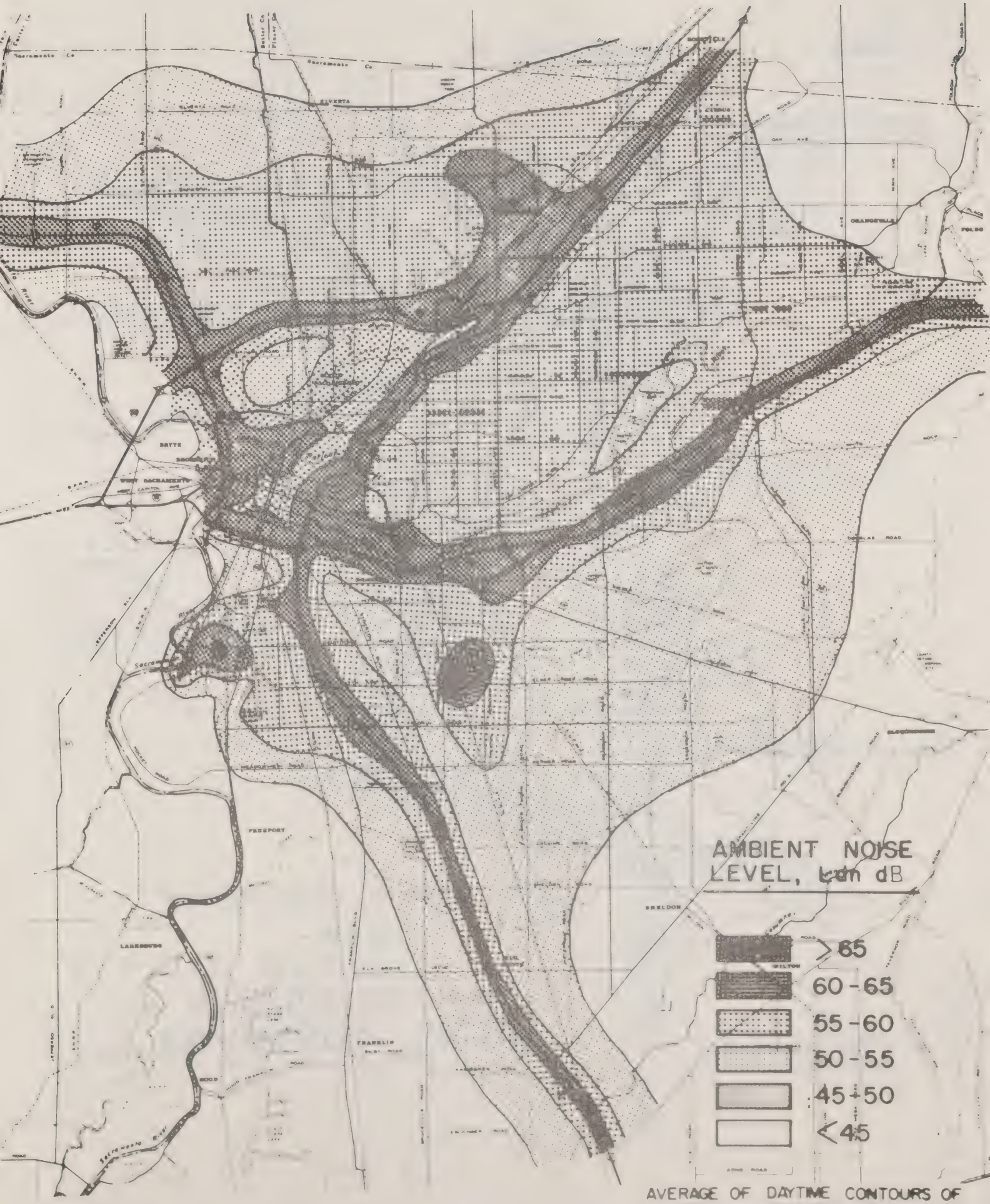
but which would provide protection inside dwellings. This only addresses the problem for new development and does not improve the situation outside.

Measure 7 is non-specific but has considerable potential. The following discussion could be considered an expansion of measure 7 to explicitly address freeways.

A. Insofar as possible, residential areas should be discouraged adjacent to freeways. Preferential uses along freeways should be agricultural, industrial, and so forth, ranging down through recreation areas and commercial areas, with residential areas, schools and churches and so on least preferred. Clearly, however, we cannot line freeways with "strip industrial."

B. If residential development must take place adjacent to freeways, several different approaches may be considered.

    1. Large-lot, single family development reduces the number of people impacted by noise.
    2. Multiple-family development allows noise insulation at a relatively lower cost per unit. In addition, there may be potential for buffering of activity areas by the buildings themselves.
    3. Very deep lots could be required for any residential development. If a lot abutting a freeway were 250' to 300' deep, permitting the dwelling to be at least 200' from the freeway, the noise impact could be substantially reduced.
    4. Finally, effective sound barriers could be required for new development adjacent to existing freeways. Under proper conditions noise attenuation of 6 to 10 dB can be achieved.

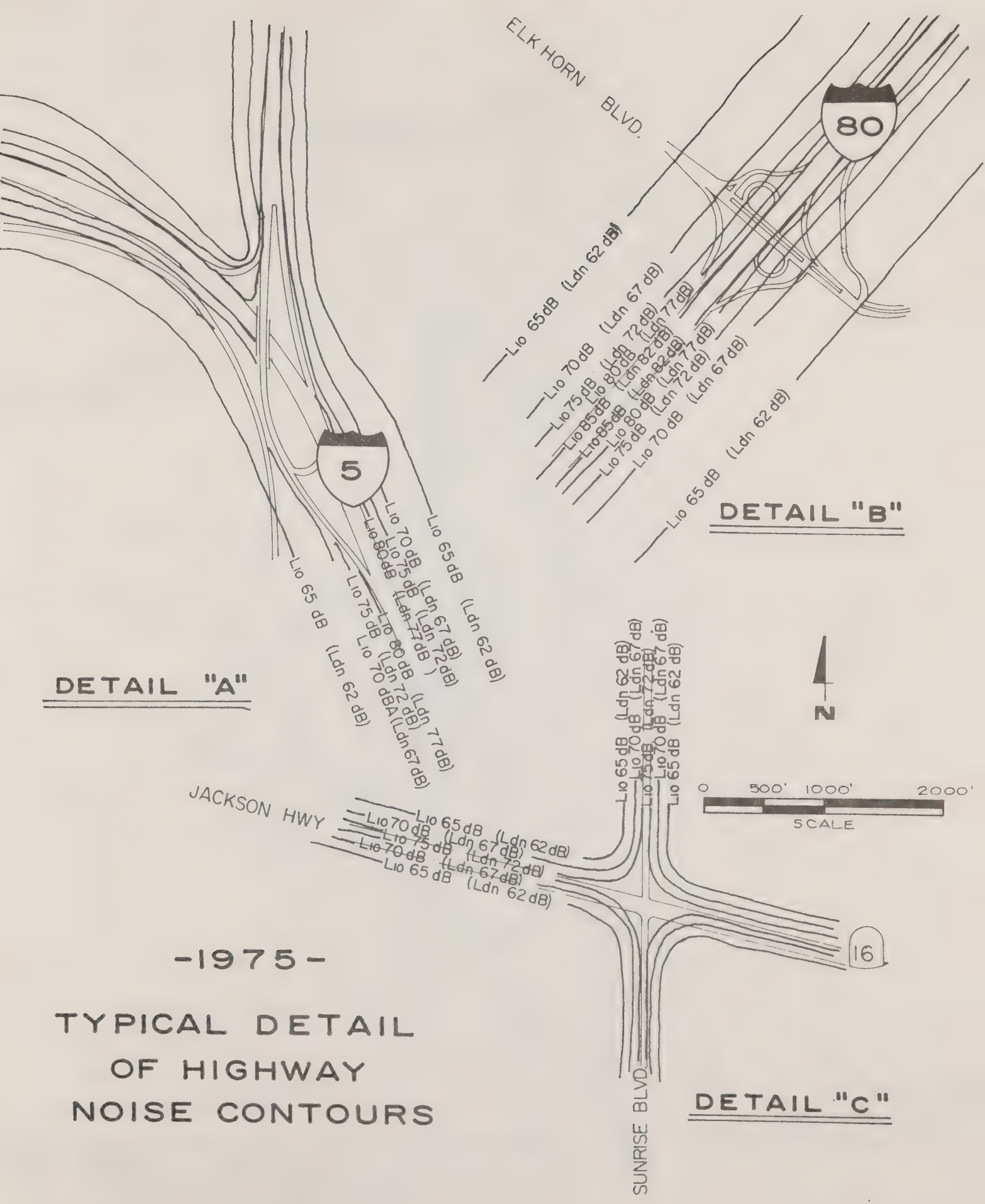


AVERAGE OF DAYTIME CONTOURS OF CONSTANT A-WEIGHTED NOISE LEVEL IN SACRAMENTO COUNTY IN MAY AND JUNE, 1973

SACRAMENTO COUNTY, CALIFORNIA

-1975-

MAJOR ROADS NOISE CONTOURS



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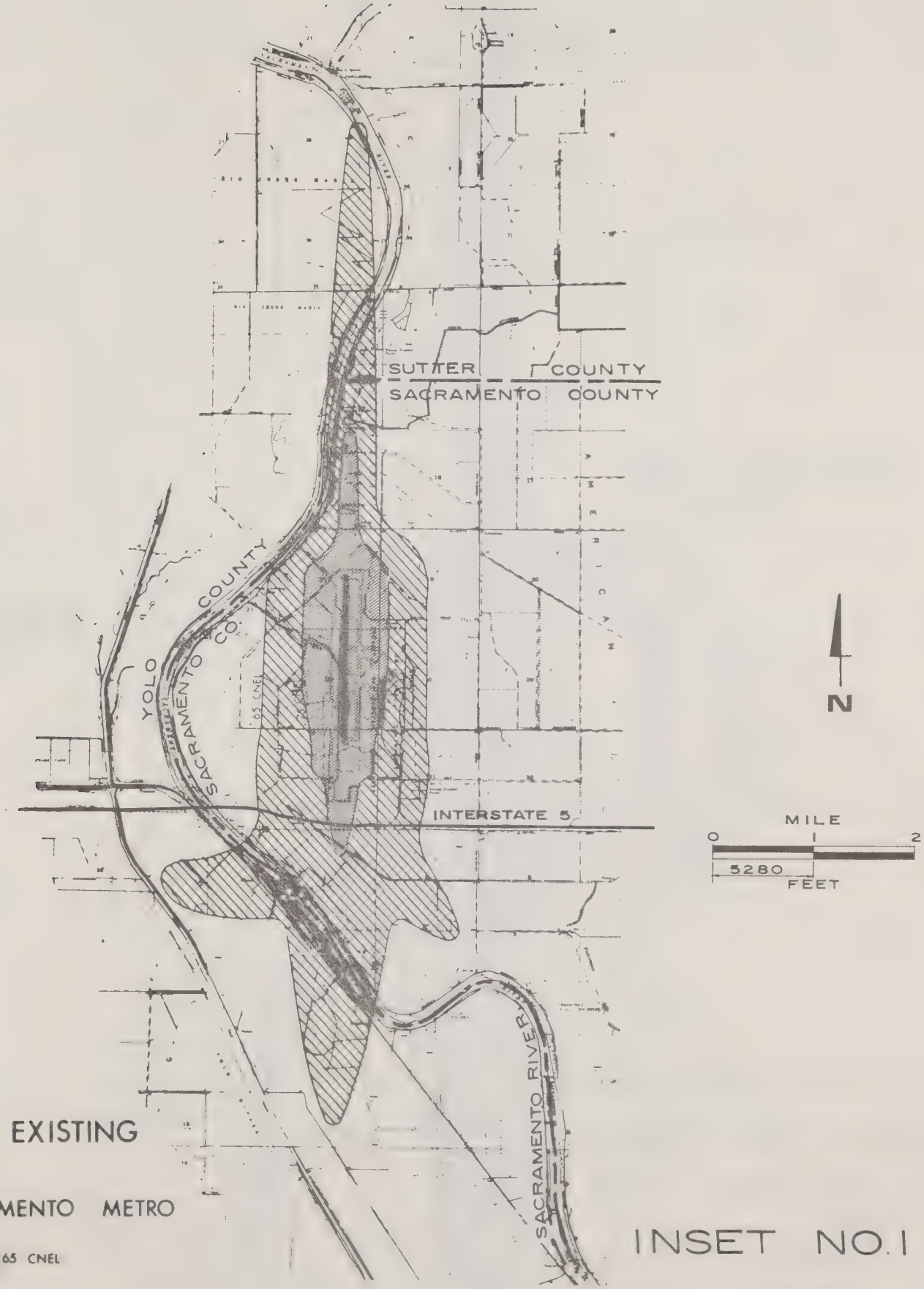
TYPICAL DETAIL OF HIGHWAY NOISE CONTOURS

SACRAMENTO COUNTY, CALIFORNIA

- 1975 -

SACRAMENTO COUNTY AIRPORT AND AIR FIELD NOISE CONTOURS



1973 EXISTING CNEL

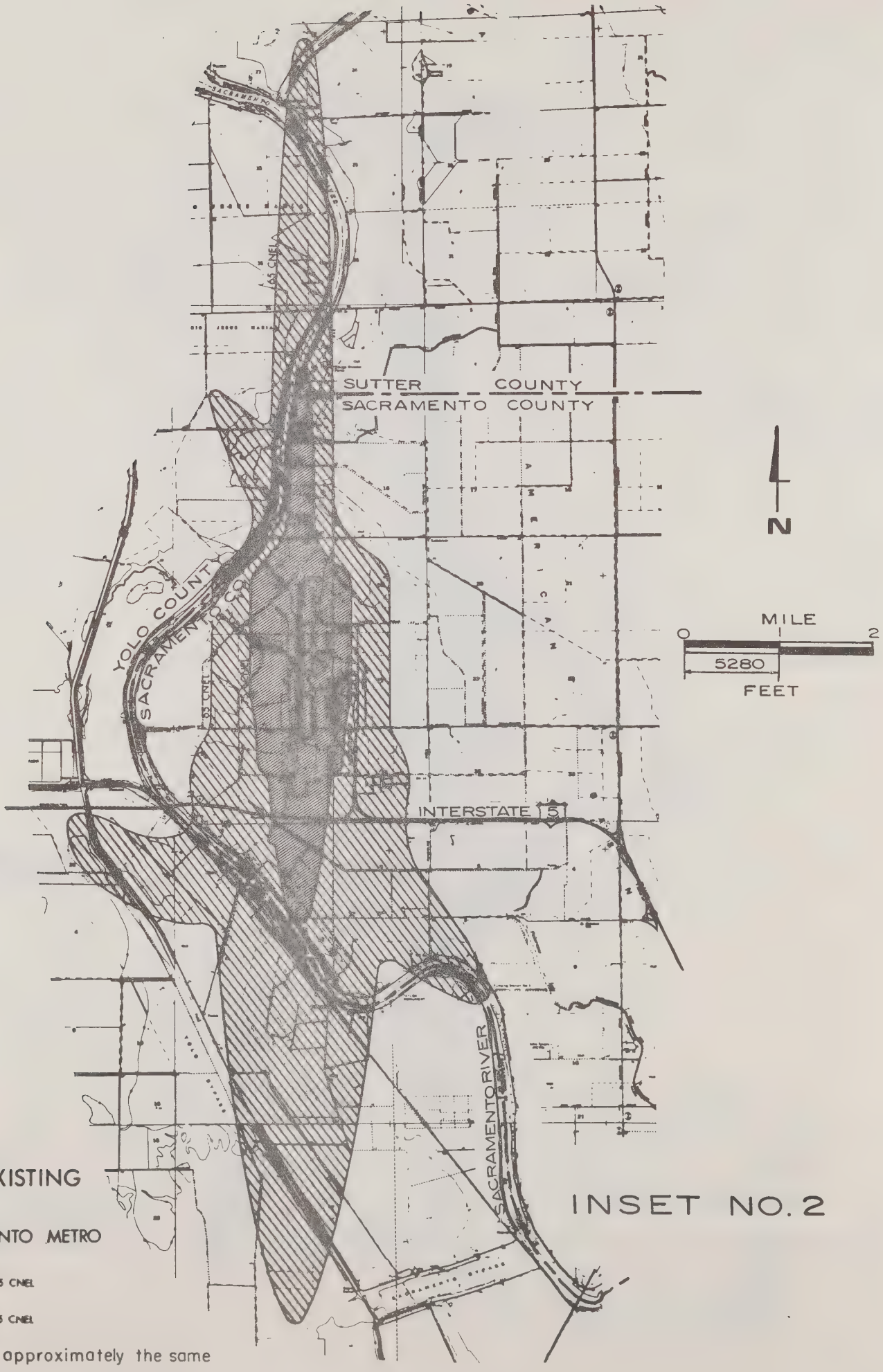
SACRAMENTO METRO

65 CNEL

75 CNEL

Ldn approximately the same

INSET NO.1



1995 EXISTING CNEL

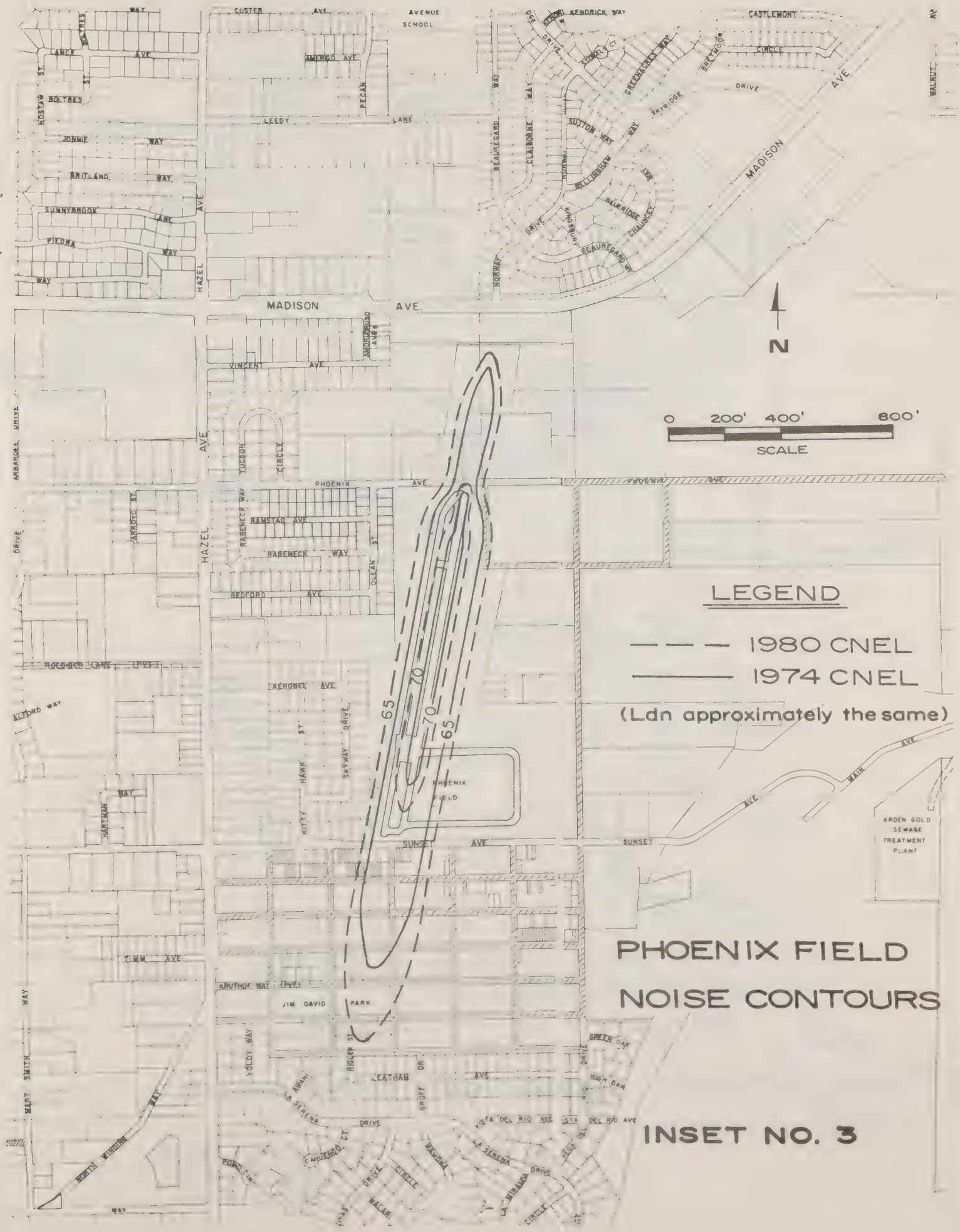
SACRAMENTO METRO

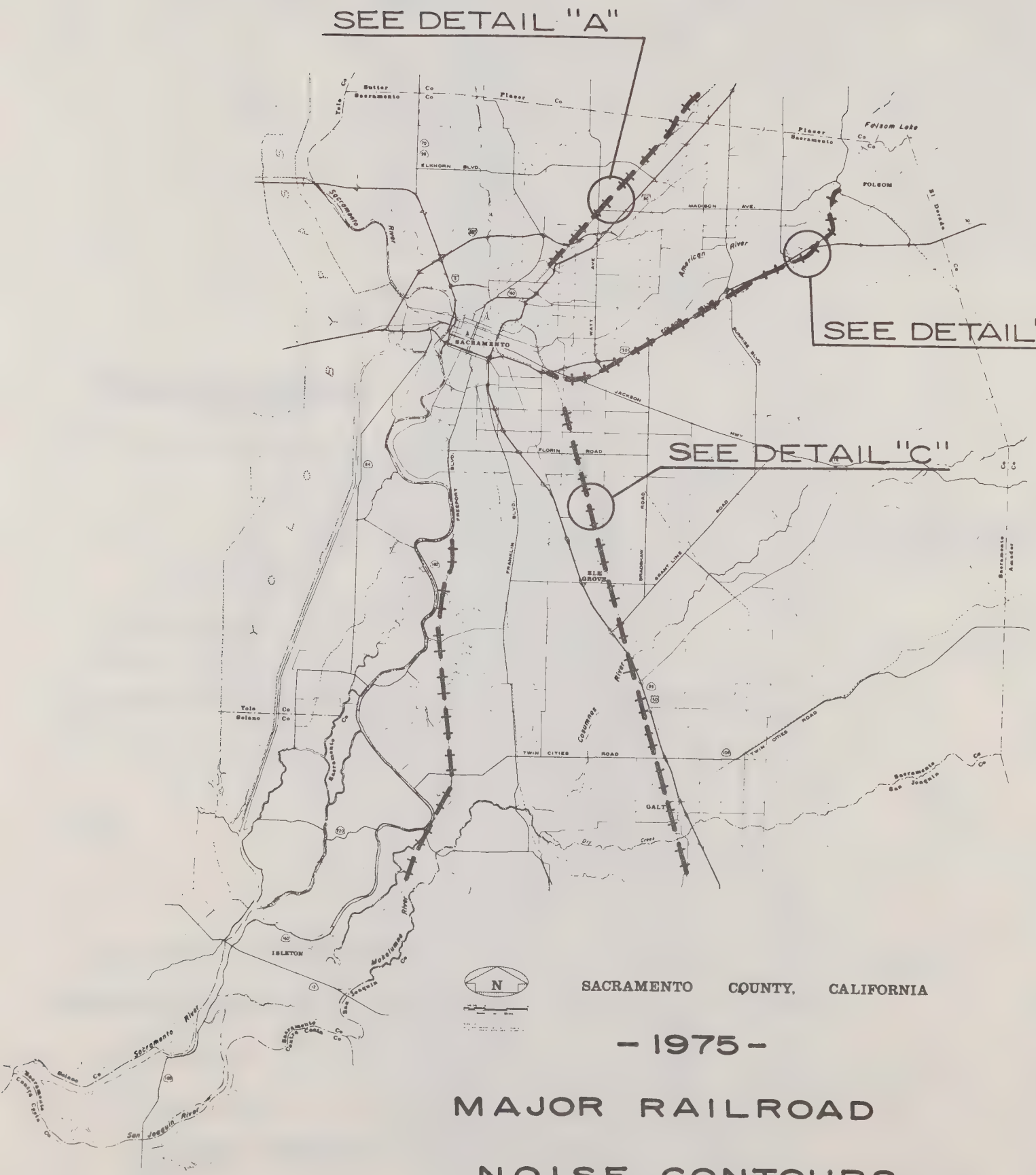
65 CNEL

75 CNEL

Ldn approximately the same

INSET NO. 2


MADISON AVE.
N
0 200' 400' 800'
SCALE
LEGEND
1980 CNEL
1974 CNEL
(Ldn approximately the same)
65
70
70
65
PHOENIX FIELD
PHOENIX AVE
SUNSET AVE
HAZEL
ARDEN GOLD SEWAGE TREATMENT PLANT
JIM DAVID PARK
PHOENIX FIELD NOISE CONTOURS
INSET NO. 3



SACRAMENTO COUNTY, CALIFORNIA

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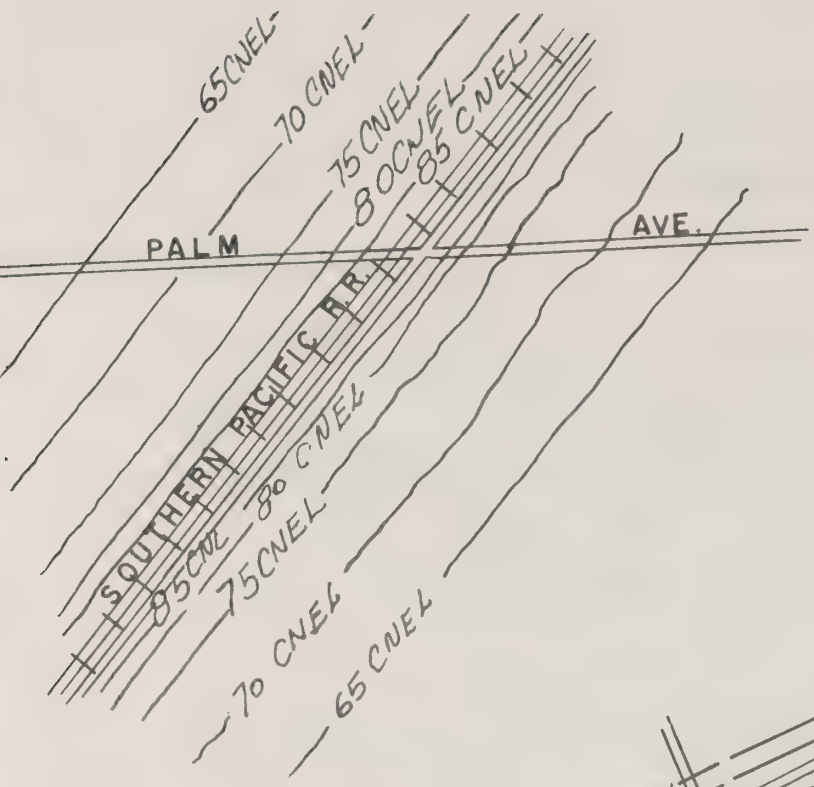
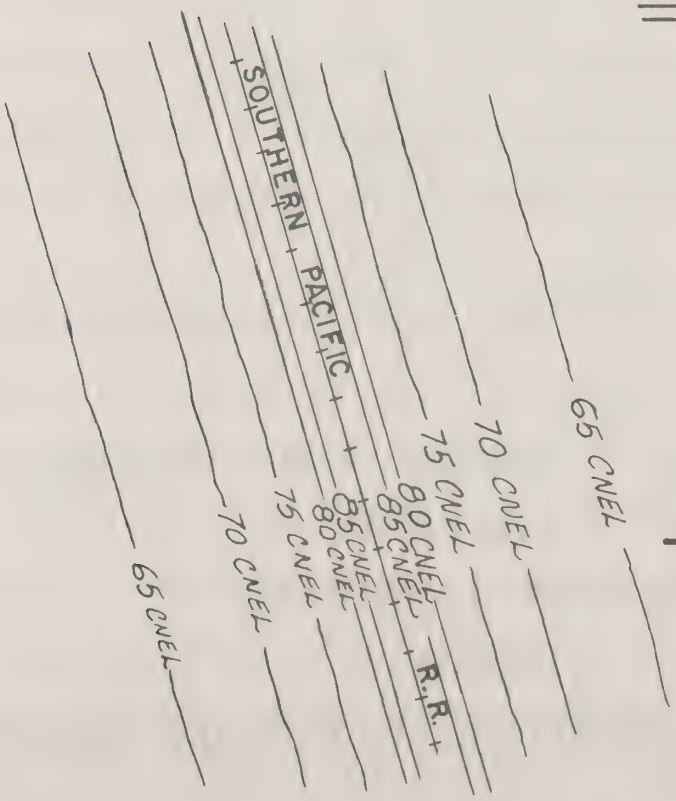
MAJOR RAILROAD NOISE CONTOURS



DETAIL "A"

DETAIL "B"

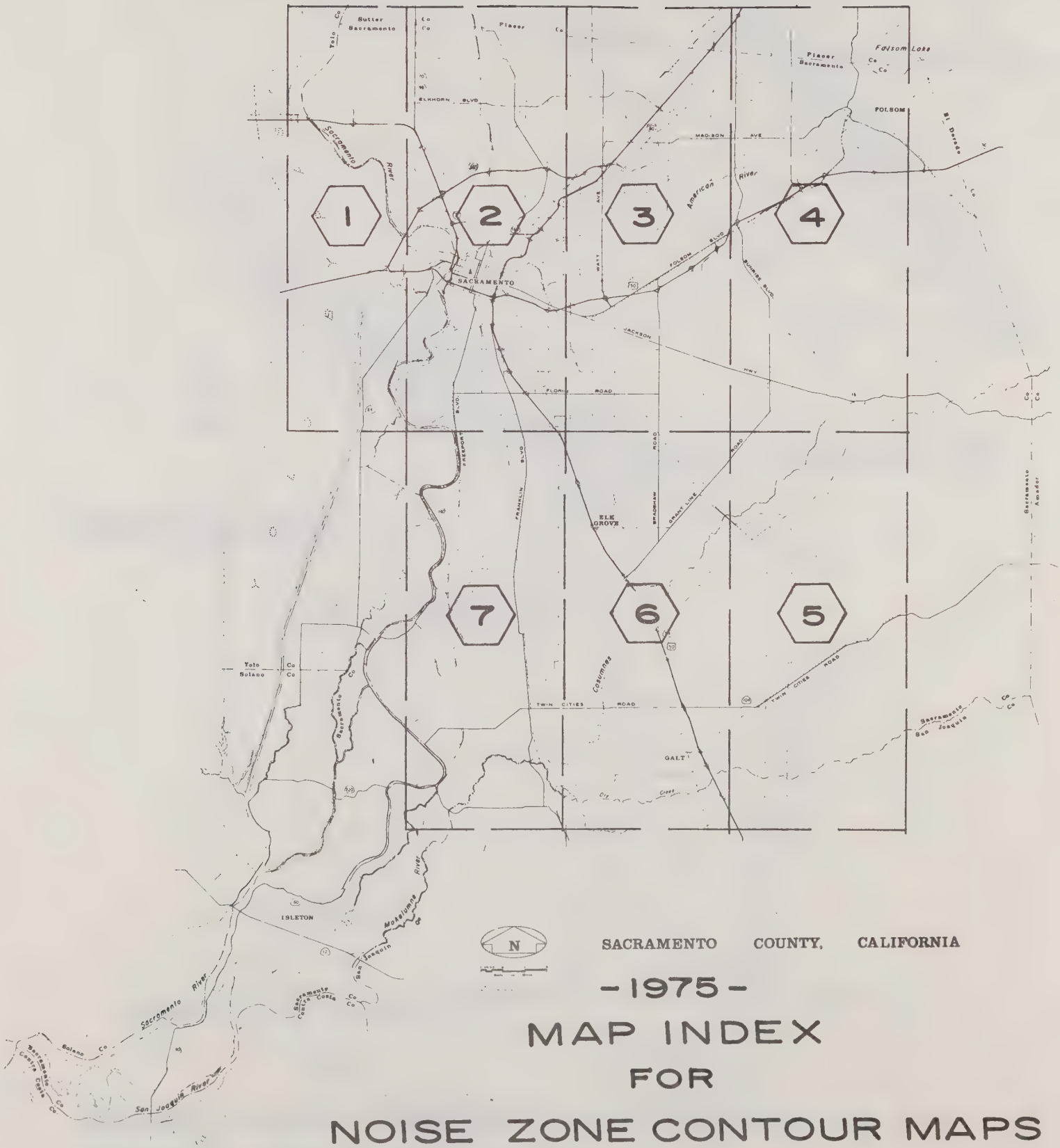


DETAIL "C"

-1975-

TYPICAL DETAIL OF NOISE CONTOURS

(Ldn approximately the same)



SACRAMENTO COUNTY, CALIFORNIA

-1975-

MAP INDEX FOR NOISE ZONE CONTOUR MAPS

ON FILE AT SACRAMENTO COUNTY PLANNING DEPARTMENT

APPENDIX "A"

Noise Descriptors

Decibels

"Decibel" abbreviated "dB", is a term having several definitions, all referring to a logarithmic ratio of two quantities. For our purposes in measuring sound, the definition is:

$$\text{SPL (Sound Pressure Level) in dB} = 10 \log \frac{P^2}{P_o^2}$$

$$= 20 \log \frac{P}{P_o}$$

where P = sound pressure in question

and P_o = reference sound pressure, by convention .0002 dynes/cm^2

The level chosen for P_o is generally considered to be the softest sound perceivable by a healthy young ear. The human ear can detect sounds with pressure level differences of magnitudes exceeding 10^{12}, so that the numbers would become very unwieldy unless logarithms were used.

The decibel notation provides a reasonable approximation of the response to sound intensity of the human ear, but must be modified to provide for the ear's frequency response characteristics. Many different modifications exist, but the most common, and one which does one of the best jobs at moderate sound levels, is the "A" weighting. A decibel reading on a meter using the "A" scale is abbreviated "dBA". This scale compensates fairly well for the lower sensitivity at high and low frequencies of the human ear. Unfortunately, decibels only take care of part of the sound description problem. All sounds

obviously have duration as well as intensity, but the dB notation does not provide for this time distribution. A number of systems which have been developed to remedy the situation.

CNEL

CNEL, or Community Noise Equivalent Level, is a system used largely by civilian airports in California. It takes into account the time of day when a noise event occurs. Events in the evening, 7:00 PM to 10:00 PM, are considered 3 times as obnoxious as daytime events, 7:00 AM to 7:00 PM. Night-time (10:00 PM to 7:00 AM) events are considered 10 times as obnoxious as daytime events.

CNEL is a calculated quantity which cannot be measured with a meter. Meter readings over a 24 hour period must be fed into an equation which yields a single number. Meter readings must be made on the "A" scale.

$$CNEL = 10 \log \frac{1}{24} \left[\Sigma(NL_d) + 3\Sigma(NL_e) + 10\Sigma(NL_n) \right]$$

where NL_d = weighted peak sound level for each daytime hour

NL_e = weighted peak sound level for each evening hour

NL_n = weighted peak sound level for each nighttime hour

CNEL usually requires considerable sophistication and a computer to calculate with any accuracy. Equipment has been developed which, once installed and calibrated, performs the neccessary calculations automatically and gives readouts in CNEL.

L_{dn}

L_{dn} or "Average Noise Level" or "Day-Night Noise Level" is essentially the same as CNEL except that the evening term is eliminated and noise events during this period are weighted the same as daytime events. This system is gradually finding increased usage and appears destined to be the descriptor of choice, at least for

the short run. As with CNEL, equipment exists to measure and calculate noise levels in L_{dn} automatically. Depending on the situation, L_{dn} levels will usually be essentially the same or slightly lower than CNEL.

CNR

CNR, Composite Noise Rating, is a measure that is falling from favor but is still used around military airports. The results are used to delineate zones of "expected response," as shown below.

$$CNR = EPNL + 10 \log (N_D + 10\ N_N) - 12$$

Where EPNL = Effective Perceived Noise Level, (see below)

and N_D = Number of daytime noise events,

N_N = Number of nighttime noise events,

again, $EPNL = PNL + D_S + F$,

where PNL = Perceived Noise Level in PNdB,

and $D_S = 10 \log (t/15)$,

F = frequency weighting factor (.17 difference between normalized 1/3 octave band and single frequency below 500 hz, .34 above 500 hz.),

also, PNdB = an arbitrary measure of annoyance or noisiness (see references)

and t = time (in seconds) during which noise level is not lower than 10 dB less than maximum PNL.

COMPOSITE NOISE RATING (AIRCRAFT)

Takeoffs and Landings	Ground Runups	Zone	Description of Expected Response
Less that 100	Less than 80	1	Essentially no complaints would be expected. The noise may, however, interfere occasionally with certain activities of the resident.
100 to 115	80 to 95	2	Individuals may complain, perhaps vigorously. Concerted group action is possible.

Over 115	Over 95	3	Individual reactions would likely include repeated vigorous complaints. Concerted group action might be expected.

No effective direct conversion exists to L_{dn} from CNR.

L_x Y

e.g. L_{10} 65 or L_{90} 95

This is the system used by CalTrans. It describes a noise level which is exceeded a certain percentage of time. L_{10} 65 means that the 65 dBA noise level is exceeded 10% of the time period in question. L_{50} 40 means that the 40 dBA noise level is exceeded half the time. The effect of using an L_{10} is to reduce somewhat the impact of peak noise levels. This may result in large trucks contributing somewhat less to the overall noise readings than they should.

The freeway noise contours supplied by CalTrans for inclusion in this element are not all the results of direct measurements along each stretch of freeway. Typical road conditions were measured and the results applied to similar conditions elsewhere.

As a rule of thumb, L_{dn} levels are 2 to 3 dB lower than L_{10} if the traffic mix contains about 10% trucks. Both L_{10} and L_{dn} labels are shown on the freeway contours.

APPENDIX "B"

METHODOLOGY FOR MEASUREMENT OF COMMUNITY NOISE (USED TO PREPARE AMBIENT NOISE CONTOUR MAP)

The method described in this Appendix produces noise contours on an L_{50} basis (see Appendix "A".) That is, a contour labelled "45 dBA" on this basis would indicate that the 45 dBA noise level was exceeded along that contour half the time. The L_{50} measurement results from the "central tendency" meter reading described in Section B of this Appendix.

The contours on the ambient noise map on page 19 are expressed in L_{dn} for consistency with the compatibility chart and other maps. Conversion of L_{50} to L_{dn} typically requires addition of 5 to 6 dB to the L_{50} level. The L_{dn} contours on the map were produced by adding 5 dB to all the previous L_{50} levels.

This conversion results in a generalized noise contour map of adequate accuracy for determination of ambient noise over broad areas. Specific noise generators, such as busy intersections, will of course create localized "hot spots" of noise. No one should expect to find the map perfect to the last dB at all locations. It does, however, indicate overall noise patterns in Sacramento County.

A. Preliminary Preparation

1. Before each measurement, check the battery condition of the sound level meter. Replace battery - one size C alkaline battery for the GR 1565-A sound level meter - if necessary.
2. Frequent calibration should be made by using an acoustical calibrator.
3. Place the "windscreen" on the microphone for all the measurements.

B. Meter Reading Procedure

1. Set the sound level meter for the "slow" damping characteristics and to "A" weighting network for all readings, i.e. "A_S" on GR 1565-A sound level meter.
2. Observe the A-level reading for five [5] seconds and record the best estimate of central tendency and the range of the meter deflections.
3. Repeat the observations noted above until the number of central tendency readings equals or exceeds the total range [in decibels] of all the readings.
4. Find the arithmatic average of all the central tendency readings in [2] and [3] above, and call this estimate the community noise level for this particular time and location.

C. General Principles for Certain Unusual Situations

1. Measurements should <u>not</u> be made in weather conditions which may create a bias in the data. Examples of such weather conditions are:
   [a] Wind in excess of 20 mph regardless of the windscreen used.
   [b] Rain, sleet, snow or hail.
   [c] Thunder.
   [d] Wet streets or snow accumulations unless these conditions are typical for the community.
2. Measurements should <u>not</u> be made if significant changes in noise making activity or patterns occur during the sampling period. Examples of changes in noise making activities or patterns which affect the data are:
   [a] Nearby noise sources such as powermowers, pavement breakers, brush cutters or power saws.

[b] Changes in vehicular traffic flow such as closed streets, detours, or shift-change periods near industrial plants.

[c] Airline or other transportation strikes.

3. Measurements should not be made if the following conditions exist:

[a] Vehicles entering, leaving or idling in a driveway and the measurement location is very close to the driveway.

[b] Vehicle passbys or vehicle idling on roadway and the measurement location is on sidewalk.

4. Measurements should be made if the following conditions hold:

[a] Vehicles entering, leaving or idling in a driveway and the measurement location is at a distance at least as far from the driveway as it is from the roadway.

[b] Vehicle passbys or vehicle idling on roadway and the measurement location is set back at residential house boundary.

D. Guidelines on Determining Measurement Sites:

The Guidelines:

1. The first visit to each site not previously inspected should include an examination of the local area to determine the most appropriate position at the site location for measuring the typical background noise; keeping in mind that the purpose of a noise ordinance is primarily to protect people in residential and recreational situations. Other locations of interest are near hospitals, schools, parks, and churches.

2. On the first outing the group should probably all go together in order to establish consistent criteria and techniques in the selection of measurement positions at each of the sites when the individuals go out to their own territories.

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APPENDIX D

Final Environmental Impact Report for the Noise Element of the General Plan of Sacramento County

Preface

This Final Environmental Impact Report was heard as a Draft EIR on September 2, 1975. The Draft had less than 30 days review due to a legal deadline on the adoption of a noise element. At the hearing, the only comments received related to the need for additional information on the fiscal impact of the element on governmental activities. The EIR has been revised to reflect those comments, which were delivered orally by Pete Rodgers of the Highways and Bridges Division of the Department of Public Works.

Introduction

The project proposed is the Noise Element for the General Plan of Sacramento County. This Appendix is written to serve as the Environmental Impact Report for the Noise Element and fulfills the requirements of the California Environmental Quality Act (CEQA), 1970. Pursuant to the Guidelines for Implementation of CEQA, Section 15147, the specificity of this EIR corresponds to the specificity of the proposed project, and this EIR has been made a part of the element. Because most effects would be experienced on a local, project-by-project basis, the anticipated impacts are discussed only in general terms.

Extant conditions for the portions of Sacramento County that would be affected by the Noise Element are described in the text of the element and in the remainder of the General Plan. Anticipated environmental impacts would result from specific projects designed to be in conformance with this element. Impacts are discussed in relation to the topical questions required by CEQA.

Adverse Environmental Effects Which Cannot be Avoided if the Proposal is Implemented

Adverse environmental effects resulting from implementation of the project would likely consist primarily of visual degradation as a result of construction of walls or berms to be used as noise buffers in some areas. The economic impact of constructing noise reduction devices could be considered an adverse impact upon developers or, more accurately, upon home purchasers whose costs would be increased where noise reduction was necessary. This economic impact must be balanced against the unquantified economic impact of decreased work productivity due to loss of sleep attributable to noise; loss of work productivity due to premature loss of hearing; and costs for individual noise reduction devices. In short, economic costs of noise reduction devices are balanced in large part by the indirect costs of noise when such devices are not installed.

An additional adverse impact that could result from implementation of this element would involve costs that would accrue to government due to expenditures for noise barriers. The adverse

effects would be of two kinds: increased costs to taxpayers and/or lack of funds for other projects or programs due to use of funds for noise barriers. This impact would probably be insignificant in terms of individual tax bills, but could be more significant to government agencies forced to establish priorities due to limitations of funds. This fiscal effect is considered adverse where funds would come from many persons to benefit a few. That is, only the homes closest to noise barriers would benefit from reduced noise while the entire subdivision or all county taxpayers might absorb the costs. This argument is not considered valid where a change in county policy (i.e., road route) resulted in noise levels which effectively reduced the value of structures near the new noise source. In such cases, noise reduction techniques would merely restore the original value to such properties.

The fiscal impact could be reduced to some degree by utilizing noise reduction methods that had high correlation between the beneficiary and the person who pays. For example, use of increased insulation and double-paning of windows in noise-affected houses would result in increased individual home prices, but would also result in lower fuel (heating, cooling) costs. Such a pricing policy, coupled with minimizing of governmental expenses, would mitigate the fiscal impacts of implementing this element.

Irreversible Environmental Changes Which Would be Involved in the Proposed Action Should it be Implemented

Implementation of this element would result in a commitment of limited natural resources where the construction of noise

reduction devices is required. When in the form of wall insulation, the noise insulation material would serve to reduce heat transfer, thereby reducing the demand for limited natural gas resources or electricity generated by nuclear fuel. In that the element could be modified in the future, most of its aspects are not irreversible.

Relationship Between Local Short Term Uses of Man's Environment and the Maintenance and Enhancement of Long Term Productivity

A short term effect will not be significant in terms of environmental noise pollution. Long term effects could result in a considerably quieter environment as a result of the cumulative effect of noise reduction from a variety of sources in many different areas. Implementation of the project could result in a long term enhancement of productivity due to the reduction of distracting and damaging noise levels.

The project is proposed now, as opposed to reserving an option for further alternatives in the future, in order to comply with Section 65302 (G) of the Government Code.

Growth-Inducing Impact of the Proposed Action

Implementation of the proposed project is not likely to result in growth-inducing impacts for several reasons. As a whole, the element is less likely to remove constraints to growth than to place minor constraints to growth on areas affected by intense noise levels. Also, since the element is required for

all general plans in the State of California, its implementation in Sacramento County is not likely to cause intra-state population shifts by persons seeking a quieter environment. It seems very unlikely that persons would consider moving to this state due to noise elements being in effect, but if such moves did occur, they would be more attributable to State policy than to this county having a noise element.

Mitigation Measures Proposed to Minimize the Impact

Due to the general nature of this element, few mitigation measures can be proposed. The reduction of visual impacts from barriers and considerations of economic impacts can best be considered on a project-by-project basis. Energy conserving measures are considered a built-in feature of this element. Wherever wall insulation is utilized, it would have the effect of reducing heating and cooling energy use.

Alternatives to the Proposed Action

There are three possible alternatives to the proposed project, as follows:

1. No project.
2. Reduced or modified project.
3. Expanded project.

Alternatives 1 and 2 are not reasonable. The project is a State mandated element to the General Plan, and as such, must be written to satisfy the requirements of Government Code Section 65302 (G).

An expanded or enhanced project would result in more data and perhaps better analysis of noise problems in Sacramento County. However, it does not appear likely at this time that such an expanded project would result in significantly greater reduction of noise impact in the County.

This Environmental Impact Report was prepared by the Planning Department and the Environmental Impact Section of the Sacramento County Community Development and Environmental Protection Agency, 827 Seventh Street, Rm. 326, Sacramento, CA 95814.